Downstream Defender® Select
Design Data

The Downstream Defender® Select is the **new generation of advanced hydrodynamic separator** for treatment of urban surface water runoff. Its customisable performance and extended range of chamber sizes allows engineers to tailor their drainage designs to meet specific pollutant removal standards. The Downstream Defender® Select also offers easier installation with much more flexibility of pipe sizes and connections and can accept up to three inlets.

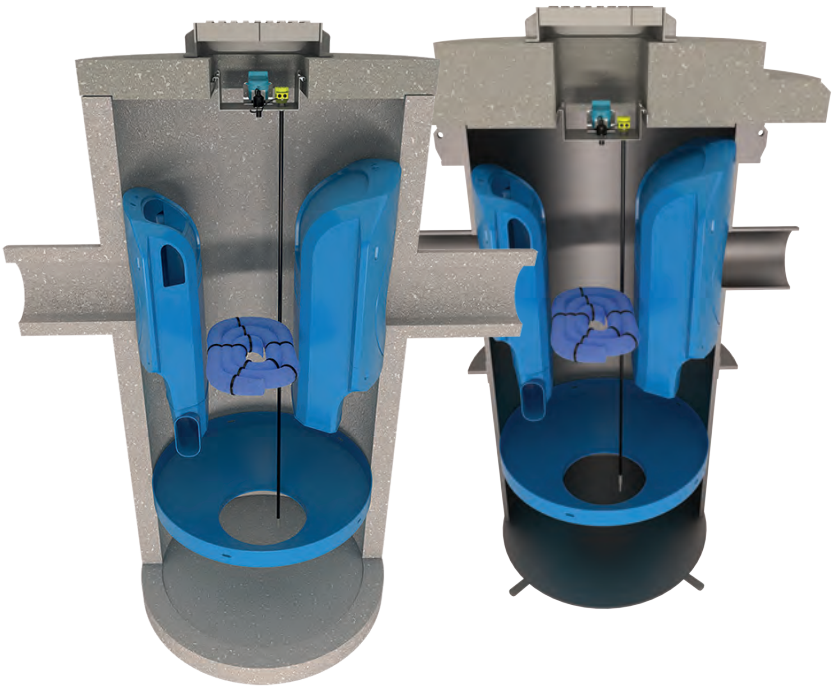


*Fig 1. Downstream Defender® Select. **Advanced Vortex** models in concrete and plastic shown with Hydro-Logic® Smart Monitoring and enhanced hydrocarbon (oil) retention options.*

Key Features

- Selectable performance levels for pollutant targets and retention.
- Extended range of chamber sizes.
- Can accept up to three inlet pipes.
- Can accept a range of pipe sizes.
- No moving parts and no power requirement.
- Available in concrete or plastic chambers.

Targeted Pollutant Removal

The Downstream Defender® Select performance can be tailored to remove some or all of the following pollutants:

Sediment (Total Suspended Solids)

The Downstream Defender® Select is a highly effective sediment/TSS removal device. It can be sized in a number of ways to suit the application and level of protection required (see Table 2).

Liquid Hydrocarbons (oils)

Effective spill containment device at low flow rates. Note these systems are not considered oil separators according to the BS EN 858-1 and must not be used in applications where full certification is required.

Gross Pollutants

100% removal of floatable debris, such as food wrappers, Styrofoam cups and drinks cartons.

Sediment Bound Heavy Metals and Nutrients

Heavy Metals | Nutrients

As an efficient device for removal of fine sediment, the Downstream Defender® Select is also effective for the removal of sediment bound pollutants.

Sediment Bound Hydrocarbons (including Polycyclic Aromatic Hydrocarbons - PAHs)

PAHs have low solubility in water and are readily adsorbed onto sediment particles. Effective removal of sediment particles will also ensure the removal of many PAHs.

Downstream Defender® Select Model Options

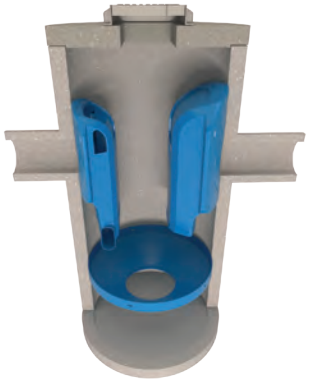
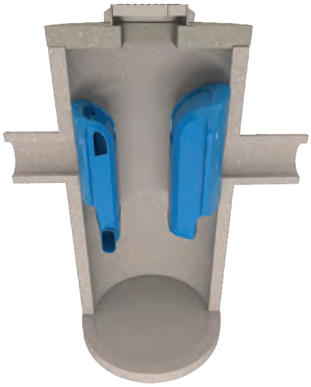
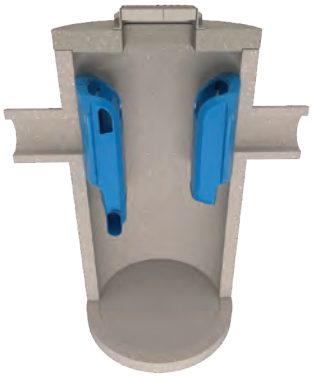
	Downstream Defender® Select Model		
	Advanced Vortex Our recommended model which provides sediments, litter and hydrocarbon (oil) removal with enhanced sediment retention up to four times the treatment flow rate. 	**Vortex Plus** Provides sediments, litter and hydrocarbon (oil) removal, with sediments retained at up to two times the treatment flow rate. 	**Vortex** A simpler model providing removal of sediments, with retention up to two times the treatment flow rate. 
Key Pollutants			
Sediments	Coarse and fine	Coarse and fine	Coarse and fine
Sediment retention	Retained up to 4 x treatment flow rate	Retained up to 2 x treatment flow rate	Retained up to 2 x treatment flow rate
Litter, debris	✓	✓	✗
Liquid hydrocarbons (oils)	✓	✓	✗
Hydrocarbon (oil) retention	Option for increased retention on request	Option for increased retention on request	✗
Sediment bound metals	✓	✓	✓

Table 1 - Downstream Defender® Select pollutant removal performance

The Downstream Defender® Select may be sized for different target particle sizes and removal efficiencies – contact us for site specific design.

Enhancement Options

Make Maintenance Smart

To help with SuDS maintenance plans and to ensure that maintenance is cost-effective, add Hydro-Logic® Smart Maintenance to any model and get automated maintenance alerts.

The Hydro-Logic® Flexi Logger and ATEX/IECEx sensors capture real-time data for flow levels and/or sediment build-up. Level monitoring will enable the detection of blockages relating to the unit, and sediment level monitoring can be set to a trigger point and self-report to the client's maintenance team when maintenance is due.

✓ **Reduce Risk** ✓ **Save Costs**

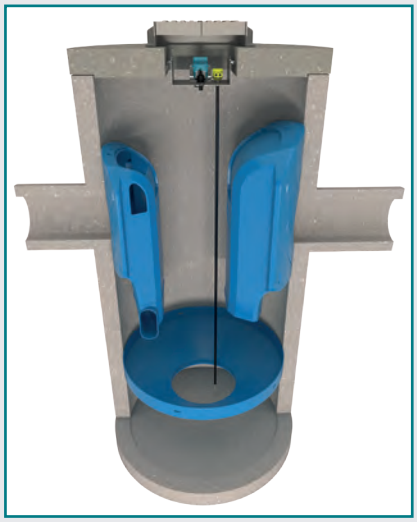


Fig 2. Downstream Defender® Select Hydro-Logic® Smart Maintenance. Available for all models.

Enhanced Oil Retention

The option of storing hydrocarbons (oils) as solids can be added, providing increased retention, even at flow rates where the unit is bypassing.

This option is available for the Advanced Vortex and Vortex Plus models only.

The Downstream Defender® Select with Enhanced Media has been tested and witnessed to the Deutches Institut für Bautechnik (DIBt) protocol for liquid hydrocarbons capture and retention, achieving 98%. The WRc Performance Declaration is available on request.

✓ **98% liquid hydrocarbon retention**

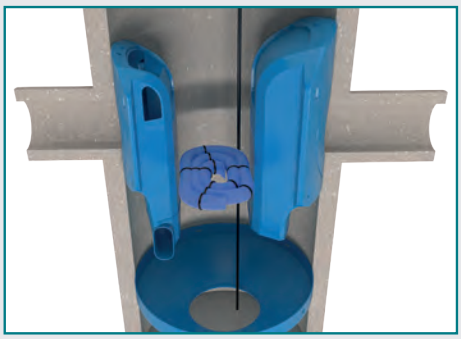


Fig 3. Enhanced hydrocarbon (oil) retention option for the Downstream Defender® Select. Available for the Advanced Vortex and Vortex Plus models only.

Pollutant Retention

It is important to ensure that pollutants in a rainfall event are retained throughout subsequent events. The Downstream Defender® Select offers engineers the option of specifying the retention performance of sediments. The **Vortex** and **Vortex Plus** models provide sediment retention up to twice the treatment flow rate, and the **Advanced Vortex**, with its benching skirt creating a calm sediment storage zone, provides sediment retention up to four times the treatment flow rate.

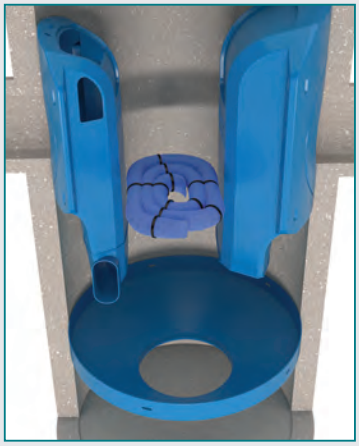


Fig 4. Downstream Defender® Select with enhanced sediment retention available for the Advanced Vortex model only.

The Simple Index Approach (SIA)

The Simple Index Approach (SIA) outlined in CIRIA C753 The SuDS Manual is a water quality design method for sites with a low to medium risk pollution hazard level. Sites with a high risk pollution hazard level should consider a more precautionary approach.

The approach assigns pollution hazard indices to the given land use for three pollutant groups, total suspended solids (TSS), metals and hydrocarbons. SuDS components are then selected until their combined pollution mitigation index score is greater than the pollution hazard index for each pollutant group.

SIA Performance Claims are only applicable when the Downstream Defender® Select is designed using Table 3 for advanced treatment designs.

Downstream Defender® Select Mitigation Indices [a][b]			
Model	**Total Suspended Solids (TSS)**	**Metals**	**Hydrocarbons (Oils)**
Vortex	0.3	0.2	0.2
Vortex Plus	0.5	0.4	0.5 / 0.6 *
Advanced Vortex	0.5	0.4	0.5 / 0.6 *
* 0.6 mitigation index requires hydrocarbon retention media supplied by Hydro International Ltd			

Notes:

(a) All mitigation indices supplied by Hydro International Ltd are calculated using the methods laid out in the British Water How To Guide: Applying the CIRIA SuDS Manual Simple Index Approach to Proprietary / Manufactured Stormwater Treatment Devices. The Advanced Vortex and Vortex Plus models have also been independently verified by the WRc, with the WRc Performance Declaration available on request.

(b) Mitigation Indices quoted for the Downstream Defender® Select are valid when the unit is designed according to the Treatment Flow Rate (see Table 3).

Table 2 - SuDS Mitigation Indices for Downstream Defender® Select

Sizing for Advanced Treatment

The Downstream Defender® Select, when designed for advanced treatment, offers an annualised removal efficiency of >50% of all particles up to 1000 microns with a mass-median particle size (D50) of 63 microns and a specific gravity of 2.65.

- Tested to the British Water Code of Practice.
- Calculations third party verified by the WRc.
- Treatment Flow Rate should be greater than or equal to the site's Water Quality Flow Rate.
- Catchment Area is calculated using an assumed M1:15 rainfall intensity of 27 mm/hr or 75 l/s/ha.
- Headloss assumes free discharge.
- Hydraulic capacity should be greater than or equal to the site's Peak Discharge Flow Rate.

Model diameter (m)	Treatment flow rate (l/s)	Catchment Area (m^2)	Headloss (mm)
1.0	21	2.800	160
1.2	30	4.000	170
1.5	48	6.400	220
1.8	69	9.200	230
2.1	94	12.500	240
2.4	123	16.000	250
3.0	192	25.600	260

Table 3 - Downstream Defender® Select design information for advanced treatment (fine particle removal).

Sizing for Basic Treatment

The Downstream Defender® Select, when designed for basic treatment, offers removal efficiencies for > 80% of particles from 150-350 microns with a mass-median particle size (D50) of 230 microns and a specific gravity of 2.65.
The supporting testing was conducted on a full size 1.2 m unit for flow rates from 10 l/s to 50 l/s.

- Treatment Flow Rate should be greater than or equal to the Water Quality Flow Rate.
- Catchment Area is calculated using an assumed rainfall intensity of 15 mm/hr or 42 l/s/ha and requires an external bypass.
- Alternative rainfall intensities can be used to size your Downstream Defender® Select
- Headloss assumes free discharge.
- Using an external bypass will allow for larger hydraulic capacity in order to exceed the site's Peak Discharge Flow Rate.

Model diameter (m)	Treatment flow rate (l/s)	Catchment Area (m^2)	Headloss (mm)
1.0	33	7.900	270
1.2	47	11.300	280
1.5	74	17.800	310
1.8	107	25.700	320
2.1	145	34.800	340
2.4	189	45.400	360
3.0	296	71.000	370

Table 4 - Downstream Defender® Select design information for basic treatment (coarse particle removal).

Sizing for Betterment

If there is no treatment objective, the Downstream Defender® Select can be designed by ensuring the hydraulic capacity of the device is greater than the site peak discharge flow rate.

More information on hydraulic capacities for Downstream Defender® Select units can be found on Page 7, Table 6.

Important Sizing Information

The Treatment Flow Rate for Basic Treatment is higher than that for Advanced Treatment. This is due to the much larger particle size distribution used for the testing. Larger particles settle more readily in the drainage network which means that they are more easily captured inside a hydrodynamic vortex separator than finer material.

Though this data is a valid way to size a Downstream Defender® Select, these larger particles are not representative of typical stormwater runoff in the UK, Europe or the USA. Official testing protocols in these regions require strict particle size distribution control during testing to ensure that performance claims are relevant for the application.

Only Downstream Defender® Select units sized according to advanced treatment methods have official particulate metals and sediment-bound hydrocarbons claims. This is because these claims are generated using the guidance in the British Water How To Guide: Applying the CIRIA SuDS Manual Simple Index Approach to Proprietary / Manufactured Stormwater Treatment Devices, which does not consider testing using larger particle size distributions.

Site Configuration

The Downstream Defender® Select can accommodate a change in pipe direction to suit site specific requirements and accept up to three inlet pipes.

Online configuration

An online Downstream Defender® Select will need to be sized to pass all flows during all storm events through the chamber.

The peak flow through an online Downstream Defender® Select is largely dependant on the diameter of the connected pipework.

Online with external bypass

An online Downstream Defender® Select with an external bypass is common for regions with high peak flows or extended storms. It will bypass the flow from large storm events around the treatment chamber using offset pipework or a weir wall.

The peak flow through this configuration of Downstream Defender® Select is largely dependant on the surrounding drainage layout.

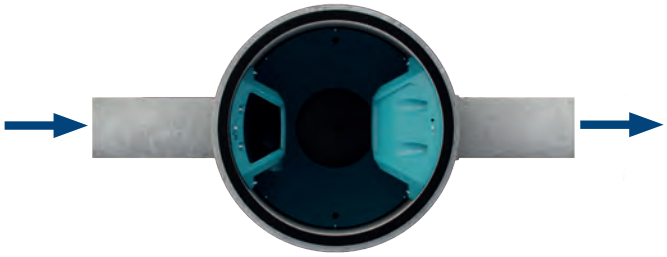


Fig 5. Downstream Defender® Select - online configuration

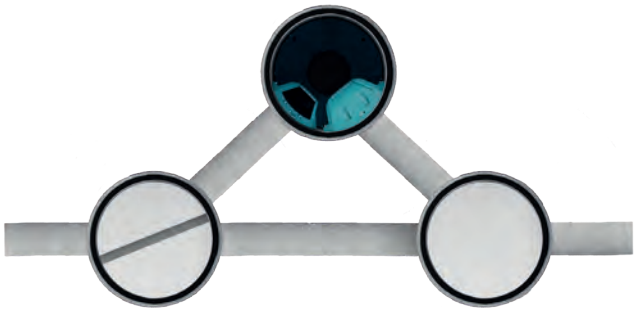


Fig 6. Downstream Defender® Select - external bypass configuration

It is recommended to design an external bypass configuration for catchments where the peak flow rainfall intensity is much larger than the treatment flow rate or average annual rainfall intensity.

Pipework

Pipe angles can be adjusted to suit. Minimum angle between inlets and outlet is 90°. All pipe connections are at the same invert level.

Please contact Hydro International with your requirements.

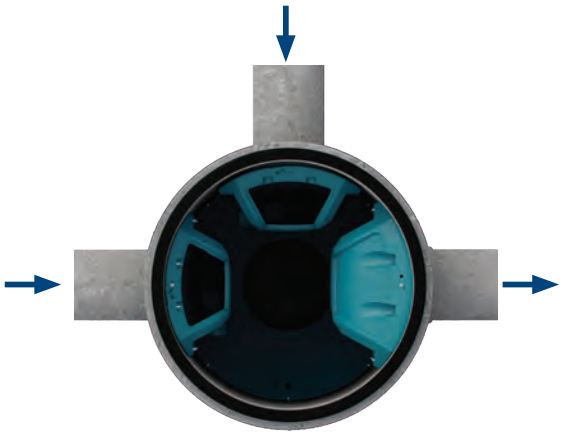


Fig 7. Downstream Defender® Select with two inlets

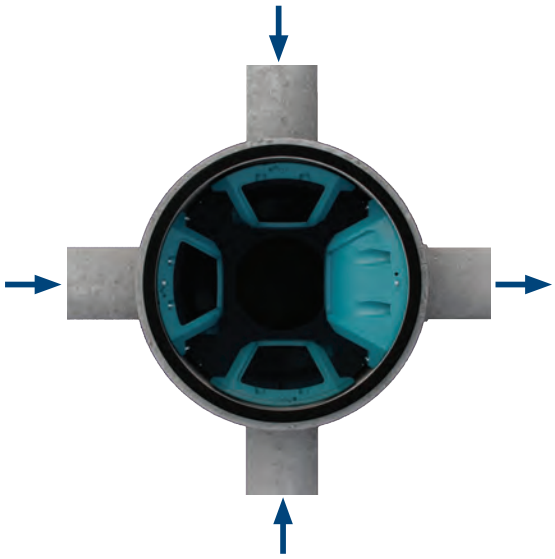


Fig 8. Downstream Defender® Select with three inlets

Pipe Sizes

The Downstream Defender® Select can accept a range of **inlet / outlet pipe** sizes, removing the need for complicated pipe connections or couplers. The inlet pipe size must always be equal to or smaller than the outlet pipe size.

Additional pipe sizes may be accommodated, please contact Hydro International for assistance.

Chamber size	1.0 m	1.2 m	1.5 m	1.8 m	2.1 m	2.4 m	3.0 m
Pipe sizes	150	150	300	375	375	500	600
	225 a)	225	375 a)	400	400	600 a)	675
	300	300 a)	400	450 a)	450	675	750 a)
		375	450	500	500 a)	750	900
				600	600		
					675		

Notes:

a) The recommended pipe size for optimum performance.

Table 5 - Downstream Defender® Select pipe sizes.

Hydraulic Capacity and Peak Flow

The hydraulic capacity or peak flow rate for an online Downstream Defender® Select is the maximum flow rate that can pass through the chamber with a maximum headloss of 500 mm. The peak flow through an online Downstream Defender® Select is largely dependant on the diameter of the connected pipework.

The hydraulic capacity or peak flow rate for an offline for a Downstream Defender Select with an external bypass can be directed around the hydrodynamic vortex separator.

Model diameter (m)	Online hydraulic capacity		External bypass hydraulic capacity [(a)] (l/s)
	with recommended outlet pipe size (l/s)	with maximum outlet pipe size (l/s)	
1.0	46	70	220
1.2	84	107	320
1.5	144	170	500
1.8	217	278	720
2.1	271	355	980
2.4	422	529	1280
3.0	652	787	2000

Notes:

a) Values calculated using the catchment area for Basic Treatment in Table 3 and an assumed peak rainfall intensity of 101 mm/hr or 280 l/s/ha.

Table 6 - Downstream Defender® Select approximate hydraulic capacity.

Model diameter (m)	Oil Storage Capacity (l)		Minimum sediment storage capacity [c] (m^3)
	Minimum liquid hydrocarbon (oil) storage capacity up to Treatment Flow Rate [a]	Solid state storage capacity with enhanced retention option [b]	
1.0	256	43-70	0.31
1.2	442	43-70	0.45
1.5	849	85-140	0.71
1.8	1458	85-140	1.02
2.1	2550	128-210	1.39
2.4	3586	170-280	1.81
3.0	6811	231-350	2.83

Notes:

(a) Liquid oil storage capacity is valid up to the Treatment Flow Rate. Oil capture and retention is only available for the **Advanced Vortex** and **Vortex Plus** models.

(b) Permanent oil storage capacity is available when using the enhanced oil retention option (available for the **Advanced Vortex** and **Vortex Plus** models only).

(c) Additional sediment storage capacity for all Downstream Defender® Select models (**Advanced Vortex**,**Vortex Plus** and **Vortex**) can be provided to extend maintenance intervals if required.

Table 7 - Downstream Defender® Select storage capacities.

Design your own Downstream Defender® Select with our Online Design Tool

Register free and design your own Downstream Defender® Select and try out different performance objectives.

Project designs can be saved and submitted for a free review by our expert technical team if required. General arrangement drawings and quotes can also be requested from the tool for any saved design.

Visit: **hydro-int.design**

Maintenance

Periodic removal of captured pollutants is essential to the continuous, long-term functioning of your Downstream Defender® Select. The device will capture and retain sediment and oil until the sediment and oil storage volumes are full to capacity. When sediment and oil storage capacities are reached, the Downstream Defender® Select will no longer be able to store removed sediment and oil. Pollutant storage capacities are provided in Table 7.

The frequency of clean-out is determined in the field after installation. During the first year of operation, the unit should be inspected every six months or sooner to determine the rate of sediment and floatables accumulation. A simple probe such as a Sludge Judge® can be used to determine the level of accumulated solids stored in the sump.

To enable the provision of maintenance plans for planning applications, a typical maintenance schedule for a Downstream Defender® Select is shown in Table 8.

Activity	Frequency
Inspection	• Regularly during first year of installation. • Every 6 months after the first year of installation
Hydrocarbons (oils) and floatables removal	• Once per year, or as needed with sediment removal. • Following a spill in the drainage area.
Sediment removal	• As and when alerted by the Hydro-Logic® Smart Maintenance system, or • At intervals as determined by the first year's inspections • Following a spill in the drainage area.
Note: For most clean-outs it is not necessary to remove the entire volume of liquid in the vessel. Only removing the first few inches of oils/ floatables and the sediment storage volume is required.	

Table 8 - Typical maintenance schedule for a Downstream Defender® Select

We can provide full inspection and maintenance services for the Downstream Defender® Select, as well as for any other Sustainable Drainage Systems (SuDS) on your site - providing peace of mind and saving you time and money.

For more information, please call 01275 878371 or email sudservices@hydro-int.com

Dimensions and Weights for Concrete Chambers

Material	Chamber Diameter Internal - mm (A)	Chamber Diameter External - mm (includes base slab and any extrusions) (B)	Recommended Inlet and Outlet Pipe Internal Diameter- mm [1] (E)	Minimum Depth to Invert - mm [2] (C)	Total Chamber Height Including cover - mm [3] (D)	Maximum Component Lift Weight - kg [4]
Concrete	1050	1420	225	840	2390	2770
Concrete	1200	1460	300	1074	2831	2320
Concrete	1500	1760	375	1227	3276	3530
Concrete	1800	2160	450	1440	4090	5250
Concrete	2100	2650	500	1500	4364	6670
Concrete	2400	2950	600	2047	5375	8600
Concrete	3000	3480	750	1915	5437	14080

Notes:

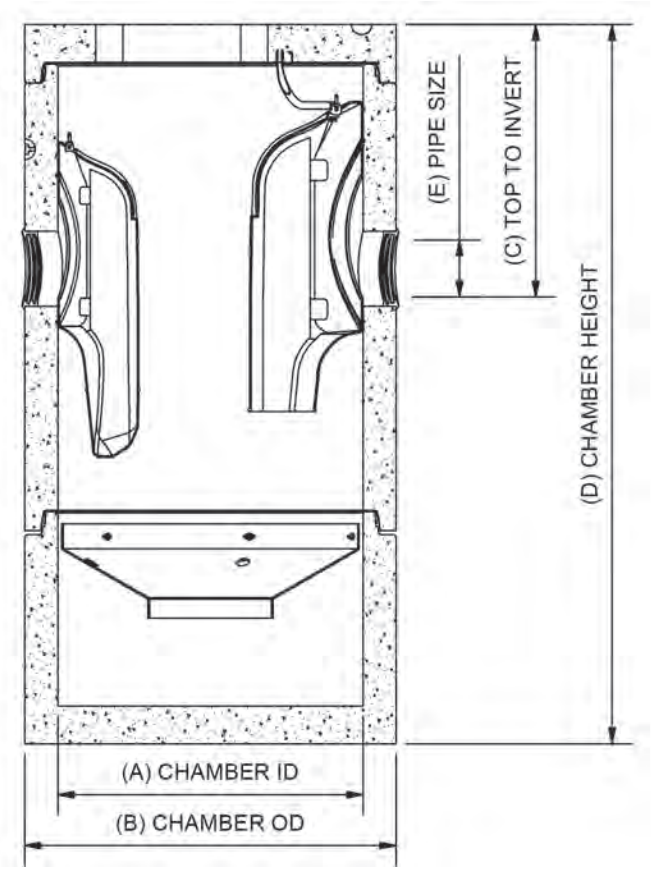
(1) Recommended inlet and outlet pipe internal diameter. For alternative pipe sizes to allow for easier connections, please see Table 5.

(2) Minimum depth to invert shown. Depth to invert can be increased if required.

(3) Minimum chamber depth shown. Additional sediment storage capacity or increased depth to invert can be provided if required. Total chamber height for concrete units **includes** the cover slab.

(4) Maximum component weight is based on a single inlet and includes internal components.

Table 9 - Downstream Defender® Select dimensions and weights for concrete chambers



SECTION A-A - SIDE VIEW

Fig 9. *Downstream Defender® Select concrete chamber dimension drawing.*

For General Arrangement drawings please email stormwater@hydro-int.com or submit a request at hydro-int.design

Dimensions and Weights for Plastic Chambers

Material	Chamber Diameter Internal - mm (A)	Chamber Diameter External - mm (includes base slab and any extrusions) [5] (B)	Recommended Inlet and Outlet Pipe Internal Diameter- mm [1] (E)	Minimum Depth to Invert - mm [2] (C)	Total Chamber Height Including cover - mm [3] (D)	Maximum Component Lift Weight - kg [4]
HDPE Single Wall	1030	1282	225	662	2012	125
HDPE Single Wall	1200	1435	300	900	2512	170
HDPE Single Wall	1500	1735	375	1036	3012	240
HDPE Single Wall	1800	2317	450	1220	3490	410
HDPE Single Wall	2100	2630	500	1350	3920	750
HDPE Single Wall	2400	2930	600	1620	4440	950
HDPE Single Wall	3000	3530	750	1700	5270	1200

Notes:

(1) Recommended inlet and outlet pipe internal diameter. For alternative pipe sizes to allow for easier connections, please see Table 5.

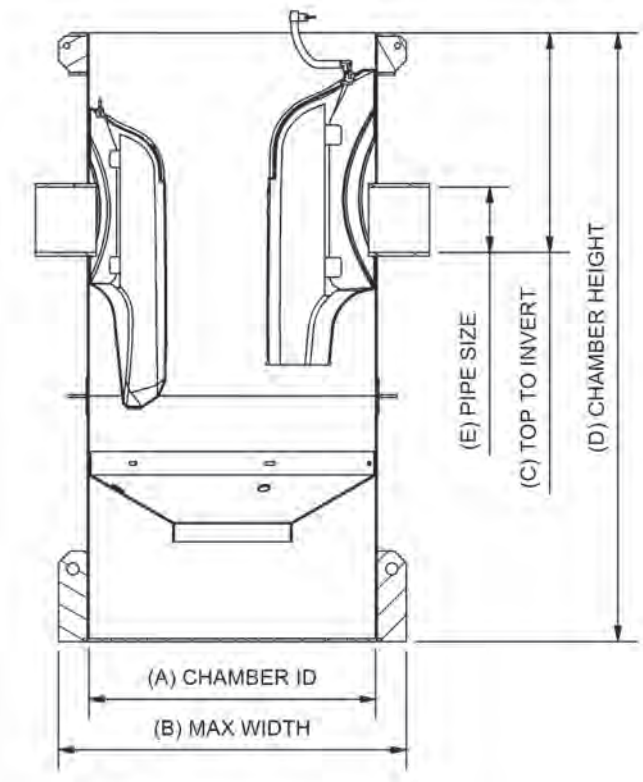
(2) Minimum depth to invert shown. Depth to invert can be increased if required.

(3) Minimum chamber depth shown. Additional sediment storage capacity or increased depth to invert can be provided if required. Total chamber height for plastic units **excludes** the cover slab.

(4) Maximum component weight is based on a single inlet and includes internal components.

(5) Maximum external diameter includes lifting lugs and base slab.

Table 10 - Downstream Defender® Select dimensions and weights for plastic chambers



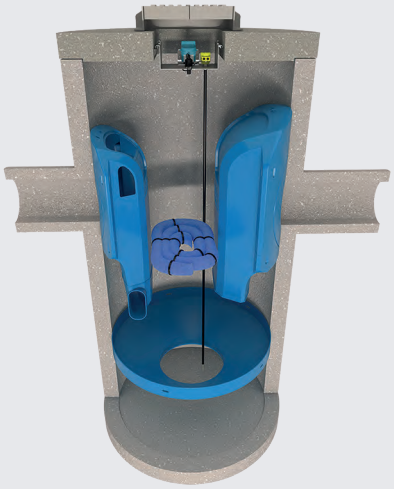
SECTION A-A - SIDE VIEW

Fig 10. *Downstream Defender® Select plastic chamber dimension drawing.*

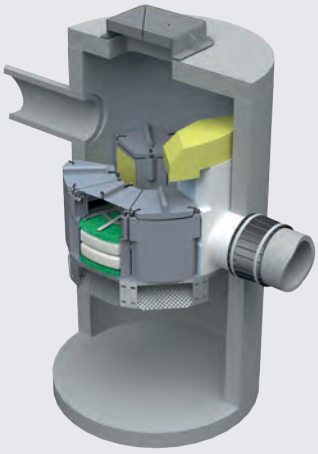
For General Arrangement drawings please email stormwater@hydro-int.com or submit a request at hydro-int.design

Our Full Range of Stormwater Treatment Solutions

We have a range of stormwater treatment devices to treat stormwater flows of varying quality. All our solutions can work alongside, enable or enhance natural SuDS, helping to meet or improve on biodiversity and amenity targets.



Downstream Defender® Select



Up-Flo™ Filter

Hydro Biofilter™

Product		Description	Targeted pollutants						
			Sediments		Litter, debris	Liquid hydrocarbons	Sediment bound hydrocarbons, nutrients and heavy metals	Dissolved metals	Nutrients
Downstream Defender® Select	**Vortex**	Vortex separator	Coarse & fine	Retained up to 2 x treatment flow rate	✗	✗	✓	✗	✗
	Vortex Plus	Vortex plus separator	Coarse & fine	Retained up to 2 x treatment flow rate	✓	✓ Option for increased retention on request	✓	✗	✗
	Advanced Vortex	Advanced hydrodynamic vortex separator	Coarse & fine	Retained up to 4 x treatment flow rate	✓	✓ Option for increased retention on request	✓	✗	✗
Up-Flo™ Filter	**Sand**	Fluidised bed up flow filtration system with **Sand media**	Very fine sediment		✓	✓	✓	✗	✓
	CPZ	Fluidised bed up flow filtration system with **CPZ media**	Very fine sediment		✓	✓	✓	✓	✓
Hydro Biofilter™		Biofiltration system	Very fine and dissolved sediments		✓	✓	✓	✓	✓

To find out more about our range of stormwater treatment solutions visit hydro-int.com.

Downstream Defender® Select Up-Flo™ Filter Hydro Biofilter™

Patent: www.hydro-int.com/patents

Tel: +44 (0)1275 337937

stormwater@hydro-int.com

Hydro International
Unit 2, Rivermead Court, Kenn Business Park
Windmill Road, Kenn, Clevedon, BS21 6FT

hydro-int.com